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Records of Porbeagles Landed in Scotland, with Observations on the Biology, Distribution and Exploitation of the Species

J A Gauld

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Introduction

The porbeagle, *Lamna nasus* (Bonnaterre, 1788) (Fig. 1), is one of the larger sharks found in north Atlantic waters. It has been exploited commercially, principally by Scandinavian fishermen, since the early 1800s. Each year small numbers of porbeagles are caught by Scottish fishing vessels in the waters around Scotland, mostly in the course of fishing for other species of fish. Although carcasses generally fetch a high price there has been no large scale exploitation of this species by Scottish fishermen.

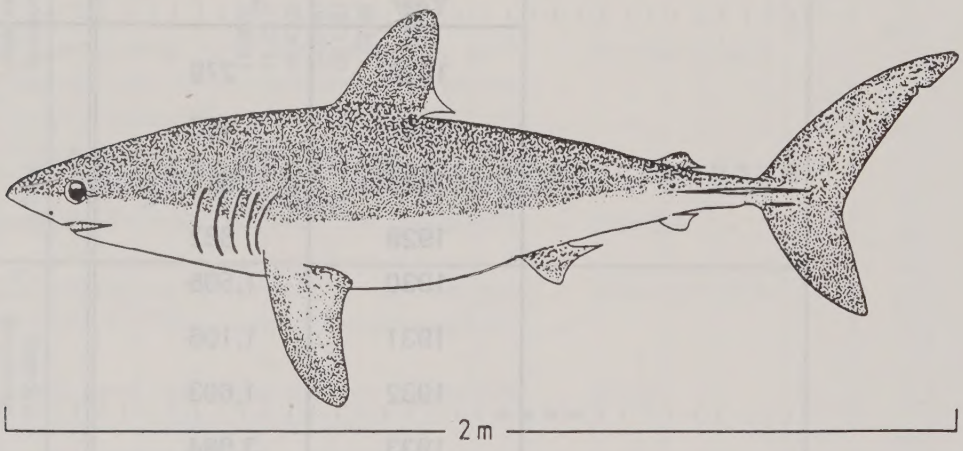

Figure 1. **Line drawing of female porbeagle shark *Lamma nasus* Bonnaterre, 1788) measuring 2 m in length.**

In the winter of 1987–88, a small fishery was maintained for a few weeks off the Shetland Isles when over 300 porbeagles were caught. As a result of this increase in landings the data on porbeagles held by the Marine Laboratory of the Department of Agriculture and Fisheries for Scotland (DAFS) were reviewed and are presented in this report. A brief account is also given of the exploitation of porbeagles in the northeast Atlantic over the past 30 years, updating the earlier work of Rae (1962).

Published information on the distribution and biology of porbeagles is scanty, and what little is known is well summarised in Compagno (1984). Features of the biology of the porbeagles examined in Scotland are described and compared with published accounts.

Fisheries

Directed fisheries for porbeagles in the North Sea and off the Scottish coast have been carried out by NOrwegian and to a lesser extent Danish vessels and to the south and west of England by French vessels. Currently there is no directed fishery in the northern waters but a small fleet of French vessels continues to fish in the south-western waters. Landings, except those for France, tend to be as an incidental by-catch in fisheries for other species of fish. A few small vessels have fished occasionally for porbeagles using shark lines in the English Channel and in the winter of 1987–88 there was also a brief shark line fishery at Shetland. In the English Channel and off the Irish coast porbeagles are regularly fished by sports fishermen but the total numbers caught each year are not known.

Landings from the commercial fisheries tend to have been poorly recorded, particularly by those countries which have had no directed fishery. The tendency has been to incorporate landings of porbeagle with those of other species under a common heading. This is demonstrated in ICES "Bulletin statistiques des pêches maritimes", where they are sometimes reported under "shark" or "various cartilaginous fish". The true quantity of porbeagles landed is not known. Also it is not always clear whether landings refer to gutted or whole weight. Reported annual landings in Norway from 1926 to 1953 are given in Table I and those in the main European countries from 1954 to 1984 in Table II. A brief resume of what is known about porbeagle landings in European countries is given below.

Table I

Total annual landings (t) of porbeagle by Norway 1926–53

Year	t	Year	t
1926	279	1940	104
1927	458	1941	283
1928	611	1942	288
1929	832	1943	352
1930	1,505	1944	321
1931	1,106	1945	928
1932	1,603	1946	1,089
1933	3,884	1947	2,824
1934	3,626	1948	1,915
1935	1,993	1949	1,251
1936	2,459	1950	1,358
1937	2,805	1951	779*
1938	2,733	1952	607*
1939	2,213	1953	713*

*provisional figures

Data sources: 1926–40 Fiskets Gang; 1941–53 Norges Fiskeristatistikk

Table II

Reported Landings (t) of porbeagle during 1954–84

Year	Denmark	Faeroes	France	England	Iceland	German Democratic Republic	Norway Total	Norway (NW Atlantic component)	Scotland	Sweden	Total
1954	651	–	–	–	–	–	595*	–	–	–	>1,200
1955	578	–	–	–	–	–	898*	–	–	–	>1,400
1956	446	–	–	–	–	–	871	–	–	–	>1,300
1957	561	–	–	–	–	–	1,097	–	–	–	>1,600
1958	653	–	–	–	–	–	831	–	7	–	>1,600
1959	562	–	–	–	–	–	910	–	9	–	>1,500
1960	362	–	–	–	–	–	1,482	–	10	–	>1,800
1961	425	–	–	–	–	–	2,145	(1,092)	9	–	>2,500
1962	304	–	–	–	–	–	1,771	(1,327)	20	–	>2,100
1963	173	–	–	–	–	–	4,554	(4,433)	17	–	>5,400
1964	216	–	–	–	–	–	5,594	(5,505)	5	–	>5,800
1965	165	–	–	–	–	–	2,329	(2,125)	8	–	>2,500
1966	131	–	–	–	–	–	576	(358)	6	–	>700
1967	144	–	–	–	–	–	305	–	7	–	>400
1968	111	–	–	–	–	–	884	(207)	7	–	>900
1969	100*	–	–	–	–	–	699	–	3	–	>800
1970	124	–	–	–	–	–	564	–	5	–	>700
1971	311	–	–	–	–	–	111	–	7	–	>400
1972	523	–	–	4	6	6	293	–	15	1	>800
1973	158	–	–	11	2	4	230	–	10	–	>400
1974	170	–	300*	13	2	3	165	–	–	–	>300
1975	265	–	–	13	4	3	340	–	–	–	>600
1976	233	1	–	20	3	–	259	–	–	–	>500
1977	289	5	–	–	3	–	77	–	–	–	>300
1978	112	9	834	–	–	–	76	–	–	–	>3,100††
1979	72	25	1,092	†	1	–	105	–	–	1	>1,300†
1980	176	8	896	3	1	–	84	–	–	8	>1,200†
1981	158	6	768*	–	–	–	93	–	–	5	>1,000†
1982	84	17	98*	–	1	-	34	–	–	6	>200†
1983	44	12	792	–	–	–	32	–	–	5	>900†
1984	38	14	411	–	1	-	96	–	–	9	>500†

* = provisional total
† = Landings boosted from 1978 owing to inclusion of French data
†† = Landings boosted in 1978 owing to inclusion of Spanish data

Data sources: ICES Bulletin Statistique and FAO Yearbook on Fishery Statistics.

Norway

Over the period 1930–1965 Norway was the principal porbeagle fishing country (Tables I and II). A fleet of specialised vessels fished specifically for the species using shark lines. Prior to 1930 the fishery was located in the eastern North Sea, mainly during the months July–October. By 1930 the fishery had extended to the Orkney-Shetland area and to the Faeroe Islands, and by the 1950s to the waters off Ireland and fishing banks further offshore. In 1961 fishing extended to waters off the coast of New England and Newfoundland. By 1965 catches had declined, and in order to maintain economic viability many of the vessels which had fished for porbeagles switched to other species or moved to west African grounds to fish for mako shark and swordfish. Currently, Norway is allowed a quota of 200 t of porbeagles in EC waters.

Denmark

Denmark operated a fleet of specialised shark line vessels during the summer, fishing predominantly in the North Sea but latterly also extending to the north-west Atlantic. Danish vessels tended to be fewer in number than Norwegian.

Faeroe Islands

Few porbeagles have been taken by the Faeroe Islands. Catches as elsewhere are predominantly as by-catch. One shark line vessel is reported to have taken part in the north-west Atlantic fishery in 1962 (Templeman, 1963). Currently Faeroese vessels have a quota of 125 t in EC waters.

Iceland

Porbeagles are caught occasionally as by-catch in trawl and line fisheries.

Irish Republic

Ireland has no commercial porbeagle fishery, though there are sport fisheries located primarily off the south and west coasts.

Spain

Porbeagles are regularly taken as by-catch in the offshore (mid-Atlantic) long-line fishery for swordfish. In recent years landings from this fishery and by-catches in other fisheries have ranged from 18 to 58 t.

France

A directed fishery, using shark lines, is carried out in Bay of Biscay-Ireland waters (ICES subdivisions VIIa, b, d and VIIId-j) by a small fleet of vessels operating from ports in Brittany. These vessels account for approximately 75% of the French landings, the remaining 25% being as by-catch in trawl and seine fisheries.

United Kingdom

England

Occasionally a few small vessels have fished shark lines, generally in the western approaches and in the English Channel. In addition there is a regular sport fishery that takes porbeagles in the western Channel area, mostly during the summer months.

Scotland

Landings of porbeagles in Scotland have been incidental to those taken in other fisheries except during the period November 1987–February 1988. Total landings were reported annually in DAFS Scottish Sea Fishery Statistical Tables until 1973 (Table II), since when they have been placed under "other pelagic fish".

Consultations with the major Scottish shark processors indicate that some 150–300 carcasses are usually landed annually, weighing approximately 15–30 t in total. During the period 1954–1987 landings of porbeagle have also been reported to the Marine Laboratory, Aberdeen on a voluntary basis. The numbers reported each month are given in Table III and their combined distribution is shown in Figure 2. During 1957–1962 the porbeagle was the subject of a detailed study by Dr B.B. Rae of the Marine Laboratory, Aberdeen. The drop in numbers recorded after 1963 is likely to have been due to a lapse in reporting rather than a decline in

in the numbers of porbeagles caught. In 1964 the government of the Faeroe Islands extended their national fishery limits from 6 to 12 miles and as a result the numbers of porbeagles caught by Scottish vessels in that area decreased.

Table III

Numbers of porbeagles landed in Scotland reported to Marine Laboratory, Aberdeen, 1954–87

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1954			1	87	3	5	1	5	6	6	1	5	120
1955				1	3	5	7	20	4	4	5	8	57
1956		2	1		3	7	20	16	16	5	11	9	90
1957	4	1	2	1	18	11	18	42	27	19	12	10	165
1958	6	2	2	2	11	6	11	33	8	11	1	29	122
1959	9	9	32	10	37	8	7	12	14	16	13	15	182
1960	8	10	2	1	10	3	7	21	11	12	15	13	113
1961	1	1	5		4	2	11	15	16	9	22	17	103
1962	9	10	6	4	19	12	18	45	64	22	20	13	242
1963	10	16	1	7	2	1	13	47	19	11	9	11	147
1964	7	6	3	2	3	1	2	3	2	10	4	11	54
1965		8	1		3		3	5	5	9	7	1	42
1966					2	1	1		6	19	8	2	39
1967	2	3		8	7	1	7	5	2	6	8	2	51
1968	1	2	1	5	12	6	3	5		1	9	2	47
1969									1	1	3	6	11
1970		7	1	1	1		4	2	9	9	5	4	43
1971									7		9	10	26
1972	10	10		1	28	8	4	12	11	20	20	2	126
1973	8	3	1	2	2	3	2	6	9	8	8	1	53
1974	4	3		1	3		2	11	4	8		9	45
1975	6	1		3		1			3	2	2	3	21
1976	2		2				1	1	2	1	2	12	23
1977	10		1			1		1	1	6			20
1978			1		2	1	3	2			2	3	14
1979	3	1			6	3		3	4	3	7	1	31
1980		1			3	1		8	8	1	6	3	31
1981					1				2	7	3	1	14
1982	2								3	1	3		9
1983									1	2			3
1984		1					7	3	5	1			17
1985					2					3			5
1986								1	2	1			4
1987		1	1							2	23	302	329
	102	98	64	136	185	87	152	324	272	236	238	505	2,399

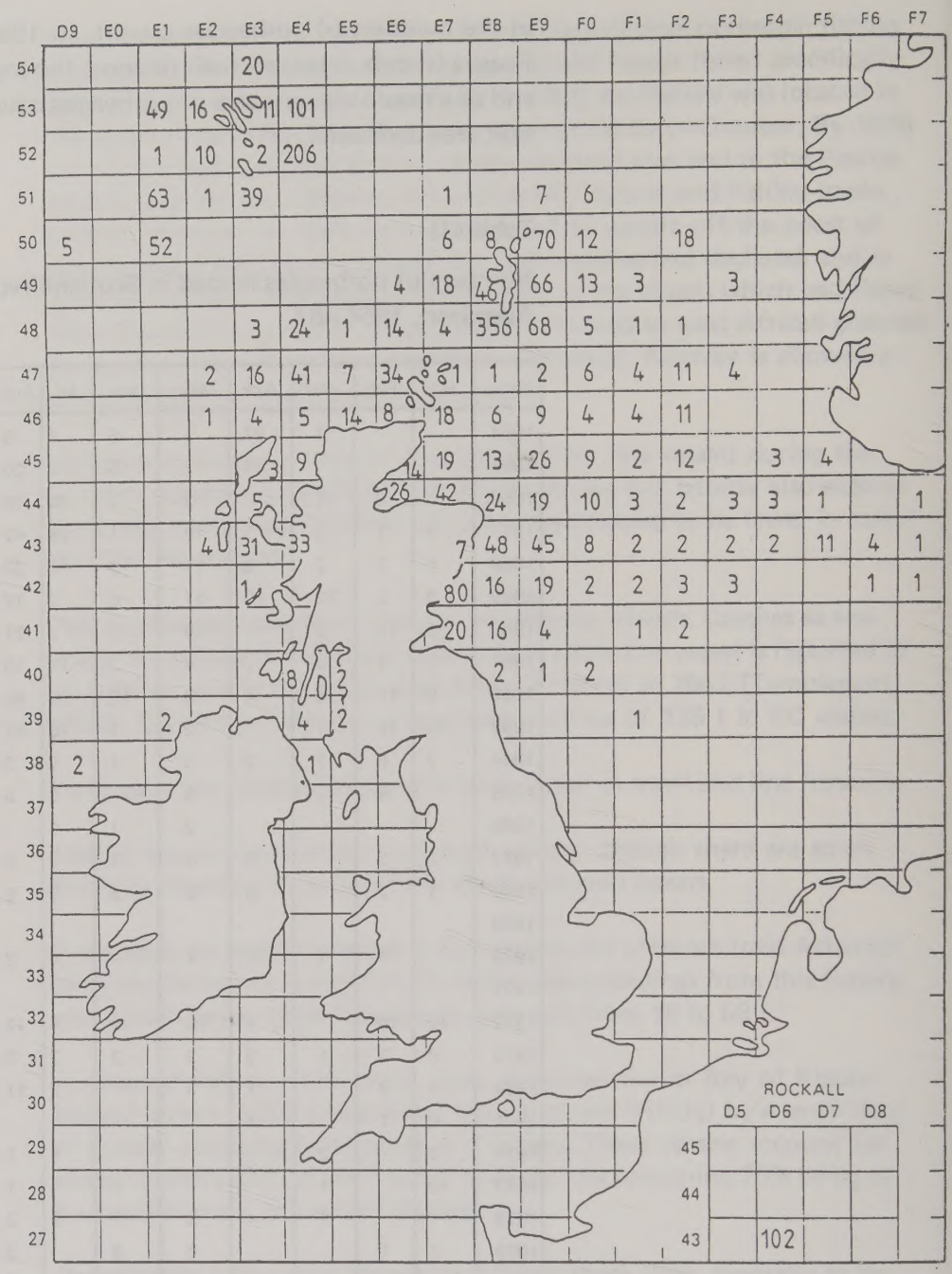

Figure 2. **Distribution of porbeagle catches reported to the Marine Laboratory, Aberdeen, during 1954–1987, catches taken by all gears combined.**

The numbers of porbeagles caught by various types of fishing gear in Scotland are given in Table IV. Those caught by the various types of trawl, including mid-water sprat trawls, have been aggregated under trawl. Those caught by pelagic gill nets include all specimens caught in salmon and herring drift nets. The decline in numbers taken by great lines and by pelagic gill nets reflects the disappearance of these methods of fishing in Scotland rather than necessarily a decline in the abundance of porbeagles.

Table IV

Numbers of porbeagles by type of fishing gear reported to Marine Laboratory, Aberdeen

Year	Method of capture								Total
	Combined trawl	Seine	Pelagic gill net	Bottom gill net	Great lines	Shark lines	Others	Unknown	
1954	12	1	4		19	84			120
1955	12	4	21		19	1			57
1956	19	4	41	9	15		2		90
1957	50	14	49	3	47	1	1		165
1958	25	13	41	4	31	7	1		122
1959	34	27	22	1	36	62			182
1960	26	44	10	5	25		1	2	113
1961	23	27	6	4	42		1		103
1962	111	30	62	6	26			7	242
1963	105	26	2		12		1	1	147
1964	25	11	1	1	11		1	4	54
1965	11	9	6	11	5				42
1966	16	9	2	11	1				39
1967	10	7	8	7	18			1	51
1968	29	6	9		3				47
1969	2	2		2	2			3	11
1970	11	17		8	2		2	3	43
1971	9	7		2	2		1	5	26
1972	65	11	7	14	8			21	126
1973	30	13		2	2			6	53
1974	18	14			11			2	45
1975	11	2		3	5				21
1976	7	13			3				23
1977	14	2	1		2			1	20
1978	5	5			1			3	14
1979	15	7		1	8			1	31
1980	21	7		1	1				31
1981	11	2			1				14
1982	6	1						2	9
1983	3								3
1984	12	3		2					17
1985	5								5
1986	3	1							4
1987	24	1		2		260	42*		329
	780	340	292	99	358	415	53	62	2,399

*Hand line

The records of sharks available to the Marine Laboratory show that the greatest numbers of porbeagles have consistently been caught during the period July to December (Table III). From catches reported by trawlers and demersal long line vessels, Rae (1962) concluded that porbeagles were present all the year round in the deep water off the Faeroe Islands but in the North Sea only during the second half of the year. The combined reported catches over 1954–1987 do not refute this conclusion (Table V). Further evidence of a seasonal immigration into the North Sea is that the Norwegian and Danish fisheries in that area were restricted mainly to the summer months.

Table V

Combined landings (t) by ICES Division reported to the Marine Laboratory, Aberdeen, per three month period during 1954–87

ICES Division	Jan–Mar	Apr–Jun	Jul–Sep	Oct–Dec	Total
IVa	75	192	274	549	1,090
IVb	19	31	120	138	308
Vb	148	40	256	140	584
VIa	5	91	23	105	224
IVb	1	45	42	3	91
Others	16	9	33	44	102
Total	264	408	748	919	2,399

Shetland fishery 1987–88

The fishery at Shetland in the winter of 1987–88 lasted from November to February. It started after a party of sea-anglers caught 25 porbeagles over two weekends in November. In December–January four small local fishing vessels (less than 14 m) fished shark lines. Peak catches were made over a 10 day period in mid-December when over 200 porbeagles were landed. In January–February three more vessels joined the fishery but catches were small, averaging only 2–3 porbeagles per vessel per fishing day. The fishery finished in early February. It is not known whether the drop in catches in January–February was related to a decrease in the availability of porbeagles, because fishing opportunities were severely restricted at that time by adverse weather conditions.

All catches were made in the area between Sumburgh Head and Fitful Head at 400 to 1,600 m (0.25–1 mile) offshore in an area of strong tidal flow. By mid-February it was estimated that 300–350 porbeagles, weighing in total 35–45 t, had been caught. In length they ranged from 190 to 250 cm, and in weight from 90 to 171 kg. Females were reported to have been more common than males in the ration of 3:2.

The value at first sale in Scotland in 1988 ranged from £750 to £1,300 per tonne, making porbeagles one of the most valuable marine species landed in Scotland weight for weight.

Biology

In the period 1954–1987 examinations were made of 1,368 specimens landed in Scotland. These observations are presented in this section and are compared with observations reported in the literature.

Sex Ratio

The sex ratio was determined from 1,368 specimens and the ratio of males to females was 1:1.3. In the north-west Atlantic Aasen (1963) reported an overall sex ratio of 1:1 in catches taken on commercial shark lines, but some catches contained a marked predominance of one or other sex. From this Aasen concluded that porbeagles shoaled according to sex. In more southern waters, off Spain and the Azores, where porbeagles are caught as by-catch in the Spanish swordfish fishery, males have outnumbered females by almost two to one (Mejuto, 1985). In these waters more porbeagles tend to be captured during winter, and the greater numbers of males suggest that there may also be seasonal differences in distribution between the sexes. Sexual segregation is not unusual in sharks.

Horizontal segregation of males and females has been reported in the spurdog, *Squalus acanthias* (L), by Ford (1921) and in the soupfin shark, *Galeorhinus galeus* (L), by Ripley (1946). Ripley (1946) also reported segregation of the sexes by depth in *G. galeus* as has Silva (1988) in the kitefin shark, *Dalatias licha* (Bonnaterre). It is not known whether male and female porbeagles segregate according to depth.

Length

Total length measurements were recorded from 592 males and 776 females. The length range of males was 81–288 cm (median = 185, mean = 206) and of females 91–317 cm (median = 199, mean = 214). Length distributions of males and females are shown separately in Figure 3. The minimum and maximum lengths reported in the literature are 74 cm (Bigelow and Schroeder, 1948) and 370 cm (Templeman, 1963).

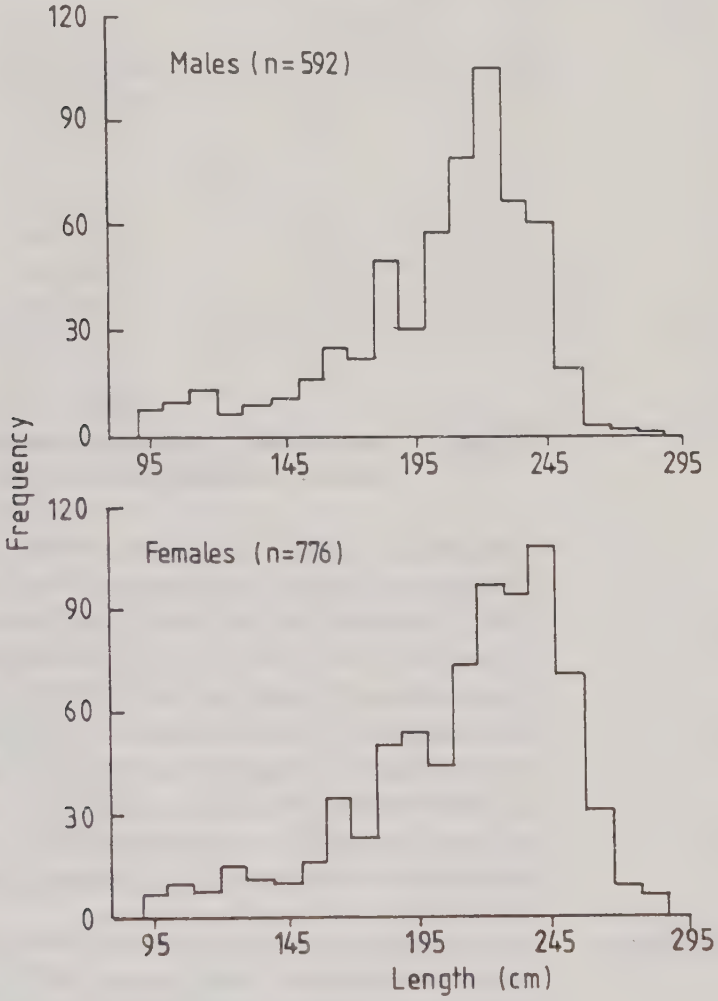

Figure 3. **Length frequency distribution of male and female porbeagles reported to the Marine Laboratory, Aberdeen, during 1954–1987.**

Body Weight

Body weight measurements are generally difficult to obtain owing to the unwieldy and large size of carcasses and the lack of suitable weighing apparatus. Based on 261 and 345 observations respectively, significant differences ($p<0.01$) were found in the whole weight/length relationship obtained for males (weight = 0.0019 length $^{2.008}$ (SE 0.082) and females (weight = 0.0003 length $^{2.357}$ (SE 0.073)). These are shown in Figure 4.

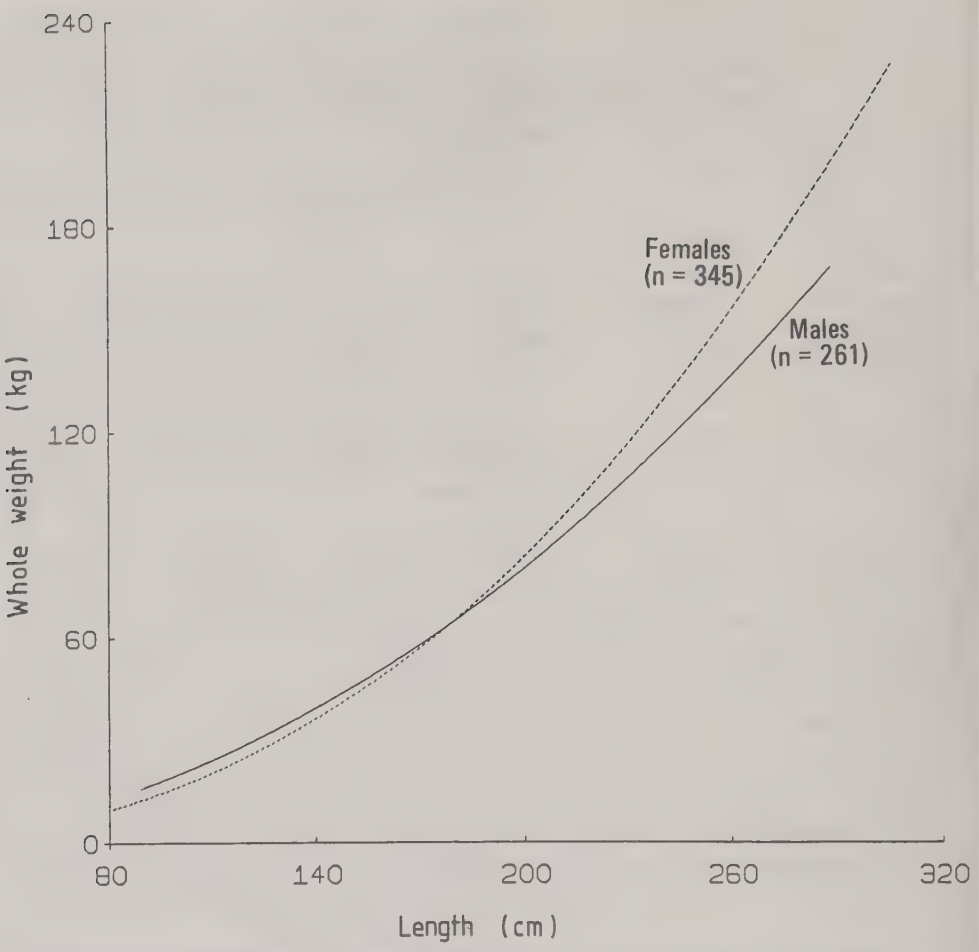

Figure 4. **Whole weight at length relationships for male and female porbeagles landed in Scotland during 1954–1987.**

Differences in body weight between males and females in other species of shark are reported to be due to differences in liver weight. Springer (1967) reported that non-gravid female carcharhinids outweighed males by at lease 25% for this reason. In porbeagles Aasen (1961) reported liver weights of up to 27 kg, equivalent to 18% body weight, although on average liver weight was approximately 8% of the body weight. The data available from Scottish specimens do not indicate major differences in weight between the sexes in small porbeagles (<2 m) and there is not enough information to determine whether the difference in weight between the sexes in larger individuals was due to liver size.

Age and Growth

Age in sharks can be determined from ring-like depositions laid down in the vertebrae (Aasen, 1963; Stevens, 1975). In porbeagles in the north-west Atlantic Aasen (1963) found no differences in growth rate between males and females and estimated a life-span greater than 20 years. For these fish the estimated length at ages 1–10 years and corresponding annual growth increments were:

Estimated age (years)	0	1	2	3	4	5	6	7	8	9	10
Length (cm)	80	110	133	153	171	188	204	219	233	247	260
Growth increment (cm)	–	30	23	20	18	17	16	15	14	14	13

No comparable data are available from Scottish specimens.

Diet

Diet was identified from the contents of 86 stomachs in which food items were present (Table VI). Each food item was identified to group or species depending on its degree of digestion. The main food groups were cephalopods and fish. Small echinoids were observed in one stomach whilst in another a whelk shell and several stones were present. It is not clear whether these items had been ingested directly as potential food or indirectly via the stomach contents of another prey species.

Table VI

Food species present in porbeagle stomachs examined at the Marine Laboratory, Aberdeen

Food species	Number of observations		
	Occurrence in stomachs	Bottom nets	Baited line
Cehhalopods	30	6	24
Fish unident	19	5	14
Herring	16	9	7
Gadoids	11	5	6
Mackerel	8	7	1
Cod	8	6	2
Haddock	6	5	1
Whiting	6	6	0
Saithe	2	2	0
Gurnard	2	2	0
Lemon sole	2	2	0
Halibut	2	2	0
Long rough dab	2	2	0
Salmon	2	1	1
Angler	2	0	2
Torsk	1	0	1
Garfish	1	0	1
Flatfish	1	1	0
Common dab	1	1	0
Plaice	1	1	0
Sprat	1	1	0
Argentine	1	1	0
Lythe	1	1	0
Sea bird	1	0	1
Echinoids	1	0	1
Whelk	1	1	0
Stones	1	1	0

Stomachs of specimens taken on baited lines were generally found to be empty except for cephalopod "beaks" or otoliths. In stomachs of porbeagles taken in demersal gear it was not unusual for large portions of two or more food species to be present.

Reproduction

The porbeagle is viviparous, giving birth to fully formed live young. The length at which maturity is first attained and at which porbeagles start to breed is not precisely known. Aasen (1961) considered that maturity occurred at lengths of 150–200 cm for males and 200–250 cm for females. Bigelow and Schroeder (1948) reported that females of 152 cm may contain embryos. Nakaya (1971) reported a mature male measuring 219 cm.

Gravid females

Reports of females bearing young are few. Of 776 females reported to the Marine Laboratory only 22 (3.1%), including six of the 229 females (2.6%) caught in December 1987 at Shetland (data from fish processors), were reported to be pregnant. This number may be somewhat low as some females in early stages of pregnancy may have been overlooked.

Gravid females have been caught by a variety of fishing gears at depths ranging from the sea surface to the sea floor. The numbers caught by type of fishing gear are given in Table VII. These females were found to be widely distributed in the waters fished by Scottish vessels but were caught only during the period December–June. The 13 gravid females for which length data are available measured 224–279 cm. The distribution and time of capture of these females are given in Table VIII.

Table VII

Numbers of gravid females caught by type of fishing gear and depth at which the gear is used

Fishing gear	Number of females caught	Depth of gear deployment
Trawl	8	Close to or on the sea bottom
Ground net	2	
Seine	1	
Great line	1	
Drift net	3	0–80 m from sea surface
Unknown	1	No data

Table VIII

The distribution of gravid females, their time of capture and the mean length (cm) of embryo in the litter

Geographic location	Month of capture	Number of females	Mean length of embryo (cm) in litter
Faeroe	January–March	4	nd: 35: 40: 45
Shetland	January–June	6	nd: 37: 40: 49: 55: 70
Shetland	December (1987)	6	<10
N Scotland	January–February	2	10: 48
Minches	March	1	49
E Scotland	February–May	2	nd: 61
Unknown	–	1	nd

nd = no data available

Number and length of embryos

The mean number of embryos per female in the 12 specimens for which data are available was 3.7. Commonly two embryos were present in each of the two horns of the uterus. The observed length range of embryos was from <10 to 77 cm and was similar to the length range reported by Shann (1923). The mean length of embryo per litter is given in Table VIII. Within litters embryos were generally of approximately the same length, but in one female caught in June embryo lengths ranged from 66 to 77 cm. Shann (1923) has reported a difference in length of 15 cm between the largest and smallest embryos within a litter. These observations suggest that length at birth may be variable. The length at birth given in the literature (Compagno, 1984) is 60–75 cm.

Parturition

The timing of parturition is uncertain. From the presence of large embryos Bigelow and Schroeder (1948) concluded that it occurred during summer, whereas Aasen (1963) has suggested late spring. In Scotland two females, one caught in May and one in June, were found to contain four and three large embryos, measuring 60–63 cm and 66–76 cm respectively, indicating that parturition is in the summer or autumn. It has been assumed that fertilisation of the next brood occurs soon after parturition (Shann, 1923), but the large numbers of large, apparently mature but, non-gravid females that have been reported suggests that there may be a gap between parturition and fertilisation. The presence of fresh bite marks on the pectoral fins of females, a common mating practice in larger sharks, (Wourms, 1977) at Shetland in December–January suggests that mating may occur at this time. It is not known whether females can store sperm from an earlier mating whilst waiting for ova to mature.

Breeding cycle

The periodicity and regularity of the breeding cycle are not known. Shann (1923) found two distinct length groupings of embryos in December–January and concluded that gestation lasted 18–24 months. The presence of two distinct size groups of embryos ($\leqslant$10 and 30–40 cm) in different Scottish specimens caught in December–February in the period 1954–1987 also suggests that gestation may last more than a year. This differs from the annual breeding cycle with an eight month gestation period proposed by Aasen (1963) and reported by Compagno (1984). Compagno and Aasen appear to have been unaware of Shann's data. A breeding cycle of more than one year is not unusual in elasmobranchs, the common spurdog, *Squalus acanthias* (L), (Ford, 1921; Templeman, 1944) and the kitefin shark, *Dalatias licha* (Bonnaterre), (Silva, 1988) both having a gestation period of two years. The period of time between successive breeding cycles in porbeagles is not known.

Oophagy

The embryos are classed as oophagous (Wourms, 1977) and derive their nourishment from the parent through a form of intra-uterine cannibalism. Food is obtained from successive crops of eggs which are released directly from the ovary into the uterus where they are ingested by the embryos. The dominant feature in an embryo is what looks like a large yellow yolk sac. This is the cardiac region of the stomach which has been enormously distended owing to ingestion of unfertiliesed eggs (Shann, 1923). The actual yolk sac is small, similar to that in the spurdog, and is absorbed during the first weeks of development.

Reproductive potential

The reproductive potential of porbeagles over their life span is not known. An estimate of total potential production can be derived from Aasen's (1963) length at age observations and his assumption that maturation in females occurs at 200–250 cm. If embryos are first produced at an age of six years and the life span is 26 years, then the breeding phase is up to 20 years. The usual number of embryos per litter is four. Assuming that females reproduce each year (Aasen, 1963) the potential number of embryos that a female can produce is 80. However, if females reproduce only every other year, as the present data and also those of Shann (1923) suggest, then total potential embryo production is halved, ie 40. If the breeding cycle exceeds two years, or if breeding is interrupted ie there is a long gap between successive pregnancies, then the potential number of progeny will be correspondingly less. A long prematuration period and low reproductive potential are not uncommon in elasmobranchs (Holden, 1974).

Discussion

Rae (1962) noted that the numbers of porbeagles landed in Scotland each year fluctuated markedly from year to year. Landings since the early 1960s have been at a fairly low level, but increased numbers were landed in Scotland in 1987 from grounds as far apart as the North Sea and Rockall. Reports from ports in the Irish Republic, Jersey and England also indicate that more porbeagles were landed in 1987 than in recent years. Other years of apparent abundance were 1962 and 1972 (Table III). The sharp fluctuations in catches between years (Rae, 1962; this study) suggest that there are fluctuations in the distribution and consequently in the availability of porbeagles. If this interpretation is correct, then it seems that only part of the total stock is available for exploitation in most years. The corollary of this is that, since the abundance of a long-lived species is not able to change rapidly, the number of fish caught each year is not a reliable index of abundance. As only a small proportion of those porbeagles reported were gravid females it appears that this part of the stock may not have been heavily exploited.

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Summary

National fisheries for porbeagle *Lamna nasus* (Bonnaterre) in the NE Atlantic are reviewed. Landings in Scotland during 1954–1987 by gear, month and area are reported and weight at length relationships for males and females calculated. Examination of stomach contents show fish and cephalopods to be the main food items. Observations on breeding, fecundity and size of embryos indicate that reproductive potential is low; each pregnancy lasts at least two years and the average number of embryos per litter is four. Few gravid females have been recorded and it is suggested that this part of the stock has not been exploited.

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